

corresponds to the velocity vector turn angle envelope.

§417.211 Debris analysis.

(a) *General.* A flight safety analysis must include a debris analysis. For an orbital or suborbital launch, a debris analysis must identify the inert, explosive, and other hazardous launch vehicle debris that results from normal and malfunctioning launch vehicle flight.

(b) *Launch vehicle breakup.* A debris analysis must account for each cause of launch vehicle breakup, including at a minimum:

- (1) Any flight termination system activation;
- (2) Launch vehicle explosion;
- (3) Aerodynamic loads;
- (4) Inertial loads;
- (5) Atmospheric reentry heating; and
- (6) Impact of intact vehicle.

(c) *Debris fragment lists.* A debris analysis must produce lists of debris fragments for each cause of breakup and any planned jettison of debris, launch vehicle components, or payload. The lists must account for all launch vehicle debris fragments, individually or in groupings of fragments whose characteristics are similar enough to be described by a single set of characteristics. The debris lists must describe the physical, aerodynamic, and harmful characteristics of each debris fragment, including at a minimum:

- (1) Origin on the vehicle, by vehicle stage or component, from which each fragment originated;
- (2) Whether it is inert or explosive;
- (3) Weight, dimensions, and shape;
- (4) Lift and drag characteristics;
- (5) Properties of the incremental velocity distribution imparted by breakup; and
- (6) Axial, transverse, and tumbling area.

§417.213 Flight safety limits analysis.

(a) *General.* A flight safety analysis must identify the location of populated or other protected areas, and establish flight safety limits that define when a flight safety system must terminate a launch vehicle's flight to prevent the hazardous effects of the resulting debris impacts from reaching any populated or other protected area and en-

sure that the launch satisfies the public risk criteria of §417.107(b).

(b) *Flight safety limits.* The analysis must establish flight safety limits for use in establishing flight termination rules. Section 417.113(c) contains requirements for flight termination rules. The flight safety limits must account for all temporal and geometric extents on the Earth's surface of a launch vehicle's hazardous debris impact dispersion resulting from any planned or unplanned event for all times during flight. Flight safety limits must account for all potential contributions to the debris impact dispersions, including at a minimum:

- (1) All time delays, as established by the time delay analysis of §417.221;
- (2) Residual thrust remaining after flight termination implementation or vehicle breakup due to aerodynamic and inertial loads;
- (3) All wind effects;
- (4) Velocity imparted to vehicle fragments by breakup;
- (5) All lift and drag forces on the malfunctioning vehicle and falling debris;
- (6) All launch vehicle guidance and performance errors;
- (7) All launch vehicle malfunction turn capabilities; and
- (8) Any uncertainty due to map errors and launch vehicle tracking errors.

(c) *Gates.* If a launch involves flight over any populated or other protected area, the flight safety analysis must establish a gate as required by §§417.217 and 417.218.

(d) *Designated debris impact limits.* The analysis must establish designated impact limit lines to bound the area where debris with a ballistic coefficient of three or more is allowed to impact if the flight safety system functions properly.

§417.215 Straight-up time analysis.

A flight safety analysis must establish the straight-up time for a launch for use as a flight termination rule. Section 417.113(c) contains requirements for flight termination rules. The analysis must establish the straight-up time as the latest time after liftoff, assuming a launch vehicle malfunctioned and flew in a vertical or near vertical